JOKELSON LAW GROUP, P.C.
ATTORNEYS AT LAW
230 South Broad St., 10th Fl.
Philadelphia, PA 19102
_____
Tel. (215) 735-7556
Fax (215) 985-0476

David E. Jokelson
Derek E. Jokelson
Debra M. Jokelson*

Derek E. Jokelson
DEJ@Jokelson.com

May 7, 2019

VIA ELECTRONIC MAIL AND ECF
Chambers of The Honorable Gerald A. McHugh
United States District Court
for the Eastern District of Pennsylvania
601 Market Street, Room 9613
Philadelphia, PA 19106

> **Re: Peruto v. Janet Kim, et al.**
> **Case Nos. 18-cv-4468 and 18-cv-4818**

Dear Judge McHugh:

I enclose the expert report of Catalin Grigoras and Jeff Smith regarding the authenticity and completeness of the May 30, 2018, audio and video recordings of Plaintiff at issue in this case. Their summary and conclusions appear on pages 7 and 8 of the report.

Respectfully,

Derek E. Jokelson
Counsel for Janet Kim,
Eli Holzman and IPC Television, LLC

cc: All counsel (*Via Email and ECF*)

1   Catalin GRIGORAS, Ph.D.

2   catalin@mda4n6.com

3   +1-720-412-3340

4

5   Jeff SMITH

6   jeff@mda4n6.com

7   +1-303-903-9959

8

9   **Report regarding forensic media authentication**

10

11 May 6, 2019

12

13 To: Counsels for the Plaintiff and Defense in

14   Peruto v. Kim, et al

15   U.S.D.C. E.D.Pa 18-cv-4468 GAM &

16   U.S.D.C. E.D.Pa 18-cv-4818 GAM

17

18 This report contains details in the analysis of three media files.

19 Each file was received by FMS, Ltd either by electronic transfer

20 or delivery of physical media upon which the hashes below were

21 confirmed substantiating digital evidence integrity.

22

23 Filename: **CHUCK_PERUTO_INTERVIEW_053018.mp4**

24 Delivery Description: digital download from the following link

25 provided by IPC Productions http://qlnk.io/ql/5cb0ea2be4b0573f512f78c0

26 on April 15, 2019

27 SHA3-256:

28 e2a19d611b83957405715f0b280f0bb2f81611f19fcd3d9402194288b9f8e9dc

29

30

31

32

33 Filename: **B008C033_180530_R0X4.mov**

34 Delivery Description: forensically transferred from G Drive

35 Thunderbolt 3 raid drive on April 17, 2019

36 SHA3-256:

37 114ea946fe72b4c89b9c18db17dab657af0073d76aae56b28290e5be4ebe6999

38

39 Filename: **INTPERUTOT01.WAV**

40 Delivery Description: forensically transferred from G Drive

41 Thunderbolt 3 raid drive on April 17, 2019

42 SHA3-256:

43 906425ef7c92db2fb639ccf07f7be8b7dff7b7348fecbc36342cd1a88cb3ee33

44

45 The forensic analysis was carried out in order to answer the

46 following questions:

47   1. Are the audio and video file(s) defendant IPC produced

48   (represented to be in their native format) consistent with

49   original audio and video files? Referring to the following

50   files:

51   a. B008C033_180530_R0X4.mov

52   b. INTPERUTOT01.WAV

53   2. Does the Combined File accurately reflect the content of the

54   audio and video files addressed in 1 above? Referring to the

55   following file as the "Combined File":

56   a. CHUCK_PERUTO_INTERVIEW_053018.mp4

57   3. Does the Arri ALEXA Mini camera have audio recording

58   capabilities? If yes, was audio recorded using the Arri ALEXA

59   Mini camera during the subject interview on 30 May 2018? If

60   not, how is this determined?

61   4. How many channels of audio can the Sound Device 633 capture

62   at one time?

63   5. How many channels of audio was the Sound Device 633 recording

64   during the subject interview on 30 May 2018?

65

66 In order to answer these questions, the following reference
67 recordings were collected on May 2, 2019 from the recording
68 equipment known to have been used for recording the subject
69 interview on May 30, 2018:
70   - B013C001_190502_R0X4.mov
71   o Arri Alexa Mini camera
72   o serial number 21192
73   - VOT05.wav
74   o Sound Devices 633 sound recorder
75   o serial number LL0515098012
76

77 During the collection of reference recordings, great care was taken
78 to ensure that the same equipment configurations and settings were
79 used on both Arri and Sound Devices equipment as was used during
80 the May 30, 2018 subject interview.
81

82 The Conclusion section of this report provides answers to the five
83 aforementioned questions.
84

85 **1. Structure and Format Analysis**
86 The comparison analysis of evidence "INTPERUTOT01.wav" and
87 reference "VOT05.WAV" files show consistent audio formats and
88 file structures as seen in Tables 1, 2, and 3.
89

90 The comparison analysis of evidence "B008C033_180530_R0X4.mov"
91 and reference "B013C001_190502_R0X4.mov" files show consistent
92 video formats and file structures as presented in Tables 4 and
93 5. Additionally, a frame level metadata extraction using Arri
94 MetaExtract v3.5.3.3 software was carried out between these two
95 files and revealed consistent frame level metadata structures.

96

97 The evidence file "CHUCK_PERUTO_INTERVIEW_053018.mp4" has a

98 different file structure and audio/video formats than the

99 "INTPERUTOT01.wav" and "B008C033_180530_R0X4.mov" evidence files

100 as shown in Table 6. The audio and video streams in this file

101 are transcoded from their original formats.

102

103 **2. Date / Time Analysis**

104 An analysis was conducted of the Embedded timestamps found

105 within each file's metadata.

106

107 The embedded date/timestamps

#	Evidence file	Encoded date	Tagged date	Explanation
1	INTPERUTOT01.wav	2018-05-30 18:58:14 (N/A*)	N/A	No Tagged date present as is consistent with reference recording VOT05.WAV
2	B008C033_180530_R0X4.mov	2018-05-30 18:53:34 (UTC)	2018-05-30 19:19:53 (UTC)	Difference between Encoded and Tagged dates is consistent with the duration of the video (26min18sec)
3	CHUCK_PERUTO_INTERVIEW_053018.mp4	2018-10-31 01:56:04 (UTC)	2018-10-31 01:56:04 (UTC)	Encoded and Tagged dates are the same as would be expected for transcoded video files

108   * Time coordinates are not embedded in the WAV file's metadata.
109 According to the Sound Devices 633 internal clock obtained on May 2nd,
110   2019 the date/time settings are EST

111 **3. Audio/Video analysis**

112 Forensic audio analysis of the evidence files was carried out

113 with respect to best practices (see References section) which

114 entails testing evidence recording properties against known

115 data. The known data in this case is "VOT05.WAV", which will

116 also be referred to as "reference audio recording".

117

118 Time domain analyses - Time domain analyses of the evidence

119 revealed no unexplainable discontinuities or events.

120

121 At about 26 min 03.773 sec from the beginning of the evidence

122 recording "INTPERUTOT01.WAV" the left channel level decreases

123 indicating that most probably the power of the microphone (BOOM

124 according to the format analysis) was switched off. The right

125 channel level does not decrease until the end of the recording

126 at 29 min 51.789 sec, indicating that the power of the right

127 channel microphone (Lavalier according to the format analysis)

128 was not switched off (See Section 7, Figure 1).

129

130 The comparison analysis between the two audio channels of

131 "CHUCK_PERUTO_INTERVIEW_053018.mp4" revealed it to be double-

132 mono, meaning the left and right channels contain the same

133 information. Therefore, only the left channel was used for

134 Frequency and MDCT analyses (below).

135

136 The   waveform   and   critical   listening   comparison   of   the

137 "INTPERUTOT01.WAV"   and   the   audio   signal   from

138 "CHUCK_PERUTO_INTERVIEW_053018.mp4" indicate that:

139 - "CHUCK_PERUTO_INTERVIEW_053018.mp4" audio signal is delayed

140   for about 23 sec at the beginning of the recording;

141 - "CHUCK_PERUTO_INTERVIEW_053018.mp4"   audio   signal   is   an

142   amplified version of audio signal "INTPERUTOT01.WAV";

143   - They contain the same dialogue.

144 Figure 1 shows the waveform comparison between "INTPERUTOT01.WAV"

145 and "CHUCK_PERUTO_INTERVIEW_053018.mp4" audio signals.

146

147 Frequency domain and MDCT analyses (See Section 7, Figures) -

148 The Power Spectral Density (PSD), Long Term Average Spectrum

149 (LTAS), Long Term Average Sorted Spectrum (LTASS), Audio

150 Compression Level (ACL), and Modified Discrete Cosine Transform

151 (MDCT) analyses of the evidence "INTPERUTOT01.WAV" revealed no

152 traces of previous lossy compression. Theses analyses, displayed

153 in Figures 2-7, along with analyses of the reference audio

154 recording in Figure 8-13 support the hypothesis that the

155 evidence file is consistent with an original Sound Devices 633

156 WAV PCM 48 kHz, 24 bit, stereo recording.

157

158 Photo Response Non-Uniformity (PRNU) analysis – The analytical

159 comparison of the evidence "B008C033_180530_R0X4.mov" to the

160 reference "B013C001_190502_R0X4.mov" Photo Response Non-

161 Uniformities generated a Logarithmic Likelihood Ratio (LLR)

162 value of 48.5914 with an Error rate of 1.5763e-12%. This can be

163 interpreted as follows:

164   o It is $10^{48.5914}$ times more likely that the evidence video

165   "B008C033_180530_R0X4.mov" was recorded with the Arri

166   Alexa Mini camera, serial number 21192 than the evidence

167   video was recorded with another camera.

168   o The PRNU analysis LLR=48.5914 supports the hypothesis

169   that the evidence video "B008C033_180530_R0X4.mov" was

170   recorded with the Arri Alexa Mini camera, serial number

171   21192.

172

173

174 **4. Summary**

175 Analyses of the evidence and reference files created with the

176 provided recording equipment revealed the following:

177   a) The evidence file "INTPERUTOT01.WAV" is consistent with an

178   original Sound Devices 633 recording.

179   b) The evidence recording "B008C033_180530_R0X4.mov" is

180   consistent with an original recording created with Arri

181   Alexa Mini camera, serial number 21192.

182   c) The Combined File "CHUCK_PERUTO_INTERVIEW_053018.mp4" has

183   audio and video streams originated from the

184   B008C033_180530_R0X4.mov and INTPERUTOT01.WAV evidence

185   files. Even though they are recompressed into different

186   formats, their content accurately reflects the dialogue

187   recorded in the original evidence files.

188   d) According to the User's Manual the Alexa Mini accepts two

189   audio channels through one single 5-pin Lemo connector on

190   the front of the camera.

191   e) During the subject interview on May 30, 2018, the Arri

192   ALEXA Mini camera did not record audio. We know this

193   because the structure analysis of video file

194   "B008C033_180530_R0X4.mov" shows that the audio recording

195   feature was disabled. Also the format analysis of video

196   file "B008C033_180530_R0X4.mov" shows no audio data.

197   f) The audio was recorded with a Sound Devices 633 equipment.

198   This was determined by analyzing the

199   "B008C033_180530_R0X4.mov" video, "INTPERUTOT01.WAV" audio

200   file, and the recording devices.

201   g) The Sound Device 633 has three XLR-3F inputs and three TA3

202   analog line inputs and can record up to 10-tracks

203   (channels) at one time.

204   h) During the subject interview on May 30, 2018, the Sound
205   Devices 633 recorded two audio channels.
206
5. Conclusion
208 Based on these observations, the initial questions can be
209 addressed with answers as follows:
210   1) The evidence file "INTPERUTOT01.WAV" is consistent with an
211   original Sound Devices 633 recording. The evidence
212   recording "B008C033_180530_R0X4.mov" is consistent with an
213   original Arri ALEXA Mini recording.
214
215   2) The Combined File "CHUCK_PERUTO_INTERVIEW_053018.mp4"
216   accurately reflects the dialogue recorded in the
217   "INTPERUTOT01.WAV" and "B008C033_180530_R0X4.mov" evidence
218   files in a recompressed file.
219
220   3) The Alexa Mini accepts two channels of audio, through one
221   single 5-pin Lemo connector on the front of the camera.
222
223   The audio was not recorded using the Arri ALEXA Mini
224   camera. The audio was recorded with a Sound Devices 633
225   equipment. This was determined by analyzing the
226   "B008C033_180530_R0X4.mov" video, "INTPERUTOT01.WAV" audio
227   file, and the recording devices.
228
229   4) The Sound Device 633 has three XLR-3F inputs and three TA3
230   analog line inputs, and can record up to 10-track
231   (channels) at one time.
232
233   5) The Sound Devices 633 recorded two audio channels.
234

235

236 Respectfully submitted,
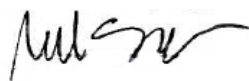
237

238 _____

239   Catalin GRIGORAS

240   05/06/2019

241

242

243 _____

244   Jeff SMITH

245   05/06/2019

246 **6. Tables**

247

248 Table 1. Audio Format Comparison Analysis

Evidence: INTPERUTOT01.wav	Reference: VOT05.WAV (EST)

General
Format   : Wave
File size   : 492 MiB
Duration   : 29 min 51 s
Overall bit rate mode: Constant
Overall bit rate   : 2 304 kb/s
Producer   : Sound Dev: Mix633 S#**LL0515098012**
Description   : sSPEED=023.976-ND
     sTAKE=01
     sUBITS=$00000000
     sSWVER=4.51.01
     sSCENE=INTPERUTO
     sFILENAME=INTPERUTOT01.WAV
     sTAPE=18Y05M30
     sCIRCLED=FALSE
     sTRK3=Boom 1
     sTRK4=LAV1
     sNOTE=
Encoded date   : 2018-05-30 18:58:14
Encoding settings   : A=PCM
     F=48000
     W=24
     M=stereo
     R=48000
     T=2 Ch
Producer_Reference : USSDV**LL0515098012**180530Iw71XT 11
	General
	Format : Wave
	File size : 6.05 MiB
	Duration : 22 s 21 ms
	Overall bit rate mode: Constant
	Overall bit rate : 2 306 kb/s
	Producer : Sound Dev: Mix633 S#LL0515098012
	Description : sSPEED=023.976-ND
	     sTAKE=05
	     sUBITS=$00000000
	     sSWVER=4.51.01
	     sSCENE=VO
	     sFILENAME=VOT05.WAV
	     sTAPE=19Y05M02
	     sCIRCLED=FALSE
	     sTRK3=BOOM
	     sTRK4=LAV1
	     sNOTE=
	Encoded date : 2019-05-02 14:26:06
	Encoding settings : A=PCM
	     F=48000
	     W=24
	     M=stereo
	     R=48000
	     T=2 Ch
	Producer_Reference : USSDV**LL0515098012**190502EQ31p6 01

Audio Format : PCM Format settings : Little / Signed Codec ID : 1 Duration : 29 min 51 s Bit rate mode : Constant Bit rate : 2 304 kb/s Channel(s) : 2 channels Sampling rate : 48.0 kHz Bit depth : 24 bits Stream size : 492 MiB (100%)	Audio Format : PCM Format settings : Little / Signed Codec ID : 1 Duration : 22 s 21 ms Bit rate mode : Constant Bit rate : 2 304 kb/s Channel(s) : 2 channels Sampling rate : 48.0 kHz Bit depth : 24 bits Stream size : 6.05 MiB (100%)

249

250   Table 2. Audio Structure Comparison Analysis

Evidence: INTPERUTOT01.wav	Reference: VOT05.WAV (EST)
Ofs: 0 => RIFF	Ofs: 0 => RIFF
Ofs: 8 => WAVE	Ofs: 8 => WAVE
Ofs: C => bextZ	Ofs: C => bextZ
Ofs: 14 => sSPEED	Ofs: 14 => sSPEED
Ofs: 27 => sTAKE	Ofs: 27 => sTAKE
Ofs: 31 => sUBITS	Ofs: 31 => sUBITS
Ofs: 43 => sSWVER	Ofs: 43 => sSWVER
Ofs: 53 => sSCENE	Ofs: 53 => sSCENE
Ofs: 65 => sFILENAME	Ofs: 5E => sFILENAME
Ofs: 81 => sTAPE	Ofs: 73 => sTAPE
Ofs: 91 => sCIRCLED	Ofs: 83 => sCIRCLED
Ofs: A1 => sTRK3	Ofs: 93 => sTRK3
Ofs: AF => sTRK4	Ofs: 9F => sTRK4
Ofs: BB => sNOTE	Ofs: AB => sNOTE
Ofs: 114 => Sound Dev	Ofs: 114 => Sound Dev
Ofs: 11F => Mix633	Ofs: 11F => Mix633
Ofs: 26E => A=PCM	Ofs: 26E => A=PCM
Ofs: 274 => F=48000	Ofs: 274 => F=48000
Ofs: 27C => W=24	Ofs: 27C => W=24
Ofs: 281 => M=stereo	Ofs: 281 => M=stereo
Ofs: 28A => R=48000	Ofs: 28A => R=48000
Ofs: 292 => T=2 Ch	Ofs: 292 => T=2 Ch
Ofs: 36F => XML	Ofs: 36F => XML
Ofs: 17E0 => fmt	Ofs: 17E0 => fmt
Ofs: 17F8 => data	Ofs: 17F8 => data

251

252   Table 3.1. Audio Structure Comparison Analysis (XML, eXtensible Markup Language)

Evidence: INTPERUTOT01.wav
`<BWFXML>`

```
<BWFXML>
     <IXML_VERSION>1.5</IXML_VERSION>
     <PROJECT>AMD</PROJECT>
     <SCENE>INTPERUTO</SCENE>
     <MEDIA_ID>5919</MEDIA_ID>
     <TAKE>01</TAKE>
     <TAPE>18Y05M30</TAPE>
     <CIRCLED>FALSE</CIRCLED>
     <UBITS>00000000</UBITS>
     <FILE_UID>USSDVLL05150980012180530Iw71XT 11</FILE_UID>
     <NOTE></NOTE>
     <SPEED>
          <NOTE></NOTE>
          <MASTER_SPEED>24000/1001</MASTER_SPEED>
          <CURRENT_SPEED>24000/1001</CURRENT_SPEED>
          <TIMECODE_FLAG>NDF</TIMECODE_FLAG>
          <TIMECODE_RATE>24000/1001</TIMECODE_RATE>
          <FILE_SAMPLE_RATE>48000</FILE_SAMPLE_RATE>
          <AUDIO_BIT_DEPTH>24</AUDIO_BIT_DEPTH>
          <DIGITIZER_SAMPLE_RATE>48000</DIGITIZER_SAMPLE_RATE>
          <TIMESTAMP_SAMPLE_RATE>48000</TIMESTAMP_SAMPLE_RATE>
          <TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_HI>0000000000</TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_HI>
          <TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_LO>3280621345</TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_LO>
     </SPEED>
     <HISTORY>
          <ORIGINAL_FILENAME>INTPERUTOT01.WAV</ORIGINAL_FILENAME>
          <CURRENT_FILENAME>INTPERUTOT01.WAV</CURRENT_FILENAME>
     </HISTORY>
     <FILE_SET>
          <TOTAL_FILES>1</TOTAL_FILES>
          <FAMILY_UID>USSDVLL05150980012180530Iw71XT 0</FAMILY_UID>
          <FILE_SET_INDEX>A</FILE_SET_INDEX>
     </FILE_SET>
     <TRACK_LIST>
```

```
        <TRACK_COUNT>2</TRACK_COUNT>
        <TRACK>
                <CHANNEL_INDEX>3</CHANNEL_INDEX>
                <INTERLEAVE_INDEX>1</INTERLEAVE_INDEX>
                <NAME>Boom 1</NAME>
        </TRACK>
        <TRACK>
                <CHANNEL_INDEX>4</CHANNEL_INDEX>
                <INTERLEAVE_INDEX>2</INTERLEAVE_INDEX>
                <NAME>LAV1</NAME>
        </TRACK>
    </TRACK_LIST>
</BWFXML>
```

253

254   Table 3.2. Audio Structure Comparison Analysis (XML, eXtensible Markup Language)

Reference: VOT05.WAV (EST)

```
<BWFXML>
        <IXML_VERSION>1.5</IXML_VERSION>
        <PROJECT>CEDAR</PROJECT>
        <SCENE>VO</SCENE>
        <MEDIA_ID>7012</MEDIA_ID>
        <TAKE>05</TAKE>
        <TAPE>19Y05M02</TAPE>
        <CIRCLED>FALSE</CIRCLED>
        <UBITS>00000000</UBITS>
        <FILE_UID>USSDVLL0515098012190502EQ31p6 01</FILE_UID>
        <NOTE></NOTE>
        <SPEED>
                <NOTE></NOTE>
                <MASTER_SPEED>24000/1001</MASTER_SPEED>
                <CURRENT_SPEED>24000/1001</CURRENT_SPEED>
                <TIMECODE_FLAG>NDF</TIMECODE_FLAG>
                <TIMECODE_RATE>24000/1001</TIMECODE_RATE>
                <FILE_SAMPLE_RATE>48000</FILE_SAMPLE_RATE>
                <AUDIO_BIT_DEPTH>24</AUDIO_BIT_DEPTH>
```

```
            <DIGITIZER_SAMPLE_RATE>48000</DIGITIZER_SAMPLE_RATE>
            <TIMESTAMP_SAMPLE_RATE>48000</TIMESTAMP_SAMPLE_RATE>
            <TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_HI>0000000000</TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_HI>
            <TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_LO>0006918913</TIMESTAMP_SAMPLES_SINCE_MIDNIGHT_LO>
      </SPEED>
      <HISTORY>
            <ORIGINAL_FILENAME>VOT05.WAV</ORIGINAL_FILENAME>
            <CURRENT_FILENAME>VOT05.WAV</CURRENT_FILENAME>
      </HISTORY>
      <FILE_SET>
            <TOTAL_FILES>1</TOTAL_FILES>
            <FAMILY_UID>USSDVLL05150980121905022EQ31p6 0</FAMILY_UID>
            <FILE_SET_INDEX>A</FILE_SET_INDEX>
      </FILE_SET>
      <TRACK_LIST>
            <TRACK_COUNT>2</TRACK_COUNT>
            <TRACK>
                  <CHANNEL_INDEX>3</CHANNEL_INDEX>
                  <INTERLEAVE_INDEX>1</INTERLEAVE_INDEX>
                  <NAME>BOOM</NAME>
            </TRACK>
            <TRACK>
                  <CHANNEL_INDEX>4</CHANNEL_INDEX>
                  <INTERLEAVE_INDEX>2</INTERLEAVE_INDEX>
                  <NAME>LAV1</NAME>
            </TRACK>
      </TRACK_LIST>
</BWFXML>
```

255

256

257

258

259

260

261   Table 4. Video Format Comparison Analysis

Evidence: B008C033_180530_R0X4.mov	Reference: B013C001_190502_R0X4.mov (EST)
General	General
Format : MPEG-4	Format : MPEG-4
Format profile : QuickTime	Format profile : QuickTime
Codec ID : qt 2005.03 (qt /ARRI)	Codec ID : qt 2005.03 (qt /ARRI)
File size : 129 GiB	File size : 119 GiB
Duration : 26 min 18 s	Duration : 26 min 19 s
Overall bit rate mode : Variable	Overall bit rate mode : Variable
Overall bit rate : 702 Mb/s	Overall bit rate : 646 Mb/s
Encoded date : UTC 2018-05-30 18:53:34	Encoded date : UTC 2019-05-02 15:41:38
Tagged date : UTC 2018-05-30 19:19:53	Tagged date : UTC 2019-05-02 16:07:57
Writing library : Apple QuickTime	Writing library : Apple QuickTime
Media/UUID : 943D97D7-A647-49EE-8135-0C1A76AFBDF2	Media/UUID : 07DA8A9A-6127-4975-91C2-8E83F87B0363
com.arri.camera.CameraId : R0X4	com.arri.camera.CameraId : R0X4
com.arri.camera.CameraIndex : B	com.arri.camera.CameraIndex : B
com.arri.camera.CameraModel : ARRI ALEXA Mini	com.arri.camera.CameraModel : ARRI ALEXA Mini
com.arri.camera.CameraSerialNumber : **21192**	com.arri.camera.CameraSerialNumber : **21192**
com.arri.camera.ColorGammaSxS : LOG-C	com.arri.camera.ColorGammaSxS : LOG-C
com.arri.camera.ExposureIndexAsa : 800	com.arri.camera.ExposureIndexAsa : 800
com.arri.camera.LookFileBurnedIn : No	com.arri.camera.LookFileBurnedIn : No
com.arri.camera.NdFilterDensity : 0	com.arri.camera.NdFilterDensity : 0
com.arri.camera.NdFilterType : 0	com.arri.camera.NdFilterType : 0
com.arri.camera.ProjectFps : 23976	com.arri.camera.ProjectFps : 23976
com.arri.camera.ReelName : B008R0X4	com.arri.camera.ReelName : B013R0X4
com.arri.camera.SensorFps : 23976	com.arri.camera.SensorFps : 23976
com.arri.camera.ShutterAngle : 1800	com.arri.camera.ShutterAngle : 1800
com.arri.camera.SupVersion : 5.02.17	com.arri.camera.SupVersion : 5.04.13
com.arri.camera.SxsSerialNumber : 31256171323390000197	com.arri.camera.SxsSerialNumber : 31256161323390005019
com.arri.camera.UserDate : 20180530	com.arri.camera.UserDate : 20190502
com.arri.camera.UserTime : 18h53m34	com.arri.camera.UserTime : 15h41m38
com.arri.camera.WhiteBalanceKelvin : 5600	com.arri.camera.WhiteBalanceKelvin : 5600
com.arri.camera.WhiteBalanceTintCc : 0	com.arri.camera.WhiteBalanceTintCc : 0
com.arri.camera.CameraClipName : B008C033_180530_R0X4.mov	com.arri.camera.CameraClipName : B013C001_190502_R0X4.mov
com.arri.camera.Product : 2	com.arri.camera.Product : 2
com.arri.camera.SubProduct : 1	com.arri.camera.SubProduct : 1
com.arri.camera.look.name : ARRI 709.AML	com.arri.camera.look.name : ARRI 709.AML
com.arri.camera.look.user_lut : 0	com.arri.camera.look.user_lut : 0
com.apple.proapps.color.asc-cdl : (Binary)	com.apple.proapps.color.asc-cdl : (Binary)
com.arri.camera.look.lut3d : (Binary)	com.arri.camera.look.lut3d : (Binary)
com.arri.camera.look.lut3d_with_cdl : (Binary)	com.arri.camera.look.lut3d_with_cdl : (Binary)
com.arri.camera.look.video_param_with_ta : (Binary)	com.arri.camera.look.video_param_with_ta : (Binary)
com.arri.camera.audio.Configuration : (Binary)	com.arri.camera.audio.Configuration : (Binary)
com.arri.camera.LensSerialNumber : 0	com.arri.camera.LensSerialNumber : 0
com.arri.camera.UnitPreference : Imperial	com.arri.camera.UnitPreference : Imperial
com.arri.camera.WbTracking : 0	com.arri.camera.WbTracking : 0

```
com.arri.camera.ImageOrientation        : 0           com.arri.camera.ImageOrientation        : 0
com.arri.camera.ImageSharpness          : 0           com.arri.camera.ImageSharpness          : 0
com.arri.camera.ImageDetail             : 0           com.arri.camera.ImageDetail             : 0
com.arri.camera.ImageDenoising          : 0           com.arri.camera.ImageDenoising          : 0
com.arri.camera.DynamicMetadataVersion  : 65536       com.arri.camera.DynamicMetadataVersion  : 65536
com.arri.camera.audio.BluetoothEnabled  : 0           com.arri.camera.audio.BluetoothEnabled  : 0
com.arri.camera.sensor.PhotoSites       : 3200x1800   com.arri.camera.sensor.PhotoSites       : 3200x1800
com.arri.camera.FramelineFileName1      : ARRI 16by9 2.39   com.arri.camera.FramelineFileName1      : ARRI 16by9 2.39
com.arri.camera.FramelineRect1A.Name    : 2.39:1_scaling100%   com.arri.camera.FramelineRect1A.Name    : 2.39:1_scaling100%
com.arri.camera.FramelineRect1A.Left    : 0           com.arri.camera.FramelineRect1A.Left    : 0
com.arri.camera.FramelineRect1A.Top     : 230         com.arri.camera.FramelineRect1A.Top     : 230
com.arri.camera.FramelineRect1A.Width   : 3199        com.arri.camera.FramelineRect1A.Width   : 3199
com.arri.camera.FramelineRect1A.Height  : 1338        com.arri.camera.FramelineRect1A.Height  : 1338
com.arri.camera.FramelineRect1A.Type    : 1           com.arri.camera.FramelineRect1A.Type    : 1
com.arri.camera.UserPixelMasking        : 0           com.arri.camera.UserPixelMasking        : 0
com.arri.camera.EfIsActive              : 0           com.arri.camera.EfIsActive              : 0
Video                                                 Video
ID                                      : 1           ID                                      : 1
Format                                  : ProRes      Format                                  : ProRes
Format version                          : Version 1   Format version                          : Version 1
Format profile                          : 4444        Format profile                          : 4444
Codec ID                                : ap4h        Codec ID                                : ap4h
Duration                                : 26 min 18 s Duration                                : 26 min 19 s
Bit rate mode                           : Variable    Bit rate mode                           : Variable
Bit rate                                : 702 Mb/s    Bit rate                                : 646 Mb/s
Width                                   : 3 200 pixels Width                                  : 3 200 pixels
Clean aperture width                    : 3 200 pixels Clean aperture width                  : 3 200 pixels
Height                                  : 1 800 pixels Height                                 : 1 800 pixels
Clean aperture height                   : 1 800 pixels Clean aperture height                 : 1 800 pixels
Display aspect ratio                    : 16:9        Display aspect ratio                    : 16:9
Clean aperture display aspect ratio     : 16:9        Clean aperture display aspect ratio     : 16:9
Frame rate mode                         : Constant    Frame rate mode                         : Constant
Frame rate                              : 23.976 (24000/1001) FPS   Frame rate             : 23.976 (24000/1001) FPS
Color space                             : YUV         Color space                             : YUV
Chroma subsampling                      : 4:4:4       Chroma subsampling                      : 4:4:4
Scan type                               : Progressive Scan type                               : Progressive
Bits/(Pixel*Frame)                      : 5.082       Bits/(Pixel*Frame)                      : 4.680
Stream size                             : 129 GiB (100%)   Stream size                         : 119 GiB (100%)
Writing library          : Arnold & Richter Cine Technik   Writing library          : Arnold & Richter Cine Technik
Language                                : English     Language                                : English
Encoded date                            : UTC 2018-05-30 18:53:34   Encoded date        : UTC 2019-05-02 15:41:38
Tagged date                             : UTC 2018-05-30 19:19:53   Tagged date         : UTC 2019-05-02 16:07:57
Color primaries                         : BT.709      Color primaries                         : BT.709
Transfer characteristics                : BT.709      Transfer characteristics                : BT.709
Matrix coefficients                     : BT.709      Matrix coefficients                     : BT.709
Other                                                 Other
ID                                      : 3           ID                                      : 3
Type                                    : Time code   Type                                    : Time code
Format                                  : QuickTime TC Format                                 : QuickTime TC
Duration                                : 26 min 18 s Duration                                : 26 min 19 s
```

```
Time code of first frame            : 18:57:37:02    Time code of first frame            : 04:58:56:11
Time code, striped                  : Yes            Time code, striped                  : Yes
Title                               : B008R0X4       Title                               : B013R0X4
Language                            : English        Language                            : English
Encoded date                        : UTC 2018-05-30 18:53:34  Encoded date              : UTC 2019-05-02 15:41:38
Tagged date                         : UTC 2018-05-30 19:19:53  Tagged date               : UTC 2019-05-02 16:07:57
```

262

263   Table 5. Video Structure Comparison Analysis

Evidence: B008C033_180530_R0X4.mov	Reference: B013C001_190502_R0X4.mov (EST)

`[ftyp] size=8+24`
`  major_brand = qt`
`  minor_version = 20050300`
`  compatible_brand = qt`
`  compatible_brand = ARRI`
`  compatible_brand = `
`  compatible_brand = `
`[wide] size=8+2097080`
`[mdat] size=16+138537861136`
`[moov] size=8+893332`
`  [mvhd] size=12+96`
`    timescale = 24000`
`    duration = 37895858`
`    duration(ms) = 1578994`
`  [trak] size=8+456560`
`    [tkhd] size=12+80, flags=f`
`      enabled = 1`
`      id = 1`
`      duration = 37895858`
`      width = 3200.000000`
`      height = 1800.000000`
`    [tapt] size=8+60`
`    [edts] size=8+28`
`      [elst] size=12+16`
`        entry count = 1`
`        entry/segment duration = 37895858`
`        entry/media time = 0`
`        entry/media rate = 1`
`    [mdia] size=8+456356`
`      [mdhd] size=12+20`
	`[ftyp] size=8+24`
	`  major_brand = qt`
	`  minor_version = 20050300`
	`  compatible_brand = qt`
	`  compatible_brand = ARRI`
	`  compatible_brand = `
	`  compatible_brand = `
	`[wide] size=8+2097080`
	`[mdat] size=16+127563464720`
	`[moov] size=8+893344`
	`  [mvhd] size=12+96`
	`    timescale = 24000`
	`    duration = 37896859`
	`    duration(ms) = 1579036`
	`  [trak] size=8+456572`
	`    [tkhd] size=12+80, flags=f`
	`      enabled = 1`
	`      id = 1`
	`      duration = 37896859`
	`      width = 3200.000000`
	`      height = 1800.000000`
	`    [tapt] size=8+60`
	`    [edts] size=8+28`
	`      [elst] size=12+16`
	`        entry count = 1`
	`        entry/segment duration = 37896859`
	`        entry/media time = 0`
	`        entry/media rate = 1`
	`    [mdia] size=8+456368`
	`      [mdhd] size=12+20`

```
     timescale = 24000                                timescale = 24000
     duration = 37895858                              duration = 37896859
     duration(ms) = 1578994                           duration(ms) = 1579035
     language = ```                                   language = ```
   [hdlr] size=12+48                                [hdlr] size=12+48
     handler_type = vide                              handler_type = vide
     handler_name = Apple Video Media Handler         handler_name = Apple Video Media Handler
   [minf] size=8+456256                             [minf] size=8+456268
     [vmhd] size=12+8, flags=1                        [vmhd] size=12+8, flags=1
       graphics_mode = 64                               graphics_mode = 64
       op_color = 0080,0080,0080                        op_color = 0080,0080,0080
     [hdlr] size=12+48                                [hdlr] size=12+48
       handler_type = alis                              handler_type = alis
       handler_name = Apple Alias Data Handler          handler_name = Apple Alias Data Handler
     [dinf] size=8+28                                 [dinf] size=8+28
       [dref] size=12+16                                [dref] size=12+16
         [alis] size=8+4                                  [alis] size=8+4
     [stbl] size=8+456132                             [stbl] size=8+456144
       [stsd] size=12+1724                              [stsd] size=12+1724
         entry-count = 1                                  entry-count = 1
         [ap4h] size=8+1712                               [ap4h] size=8+1712
           data_reference_index = 1                         data_reference_index = 1
       [stts] size=12+12                                [stts] size=12+12
         entry_count = 1                                  entry_count = 1
       [stsc] size=12+28                                [stsc] size=12+28
         entry_count = 2                                  entry_count = 2
       [stsz] size=12+151440                            [stsz] size=12+151444
         sample_size = 0                                  sample_size = 0
         sample_count = 37858                             sample_count = 37859
       [co64] size=12+302868                            [co64] size=12+302876
         entry_count = 37858                              entry_count = 37859
[trak] size=8+624                                 [trak] size=8+624
  [tkhd] size=12+80, flags=f                        [tkhd] size=12+80, flags=f
    enabled = 1                                       enabled = 1
    id = 3                                            id = 3
    duration = 37895858                               duration = 37896859
    width = 3200.000000                               width = 3200.000000
    height = 1800.000000                              height = 1800.000000
  [edts] size=8+28                                  [edts] size=8+28
    [elst] size=12+16                                 [elst] size=12+16
```

```
        entry count = 1                              entry count = 1
        entry/segment duration = 37895858            entry/segment duration = 37896859
        entry/media time = 0                         entry/media time = 0
        entry/media rate = 1                         entry/media rate = 1
     [mdia] size=8+456                            [mdia] size=8+456
       [mdhd] size=12+20                            [mdhd] size=12+20
         timescale = 24000                            timescale = 24000
         duration = 37895858                          duration = 37896859
         duration(ms) = 1578994                       duration(ms) = 1579035
         language = ```                               language = ```
       [hdlr] size=12+48                            [hdlr] size=12+48
         handler_type = tmcd                          handler_type = tmcd
         handler_name = Time Code Media Handler       handler_name = Time Code Media Handler
       [minf] size=8+356                            [minf] size=8+356
         [gmhd] size=8+80                             [gmhd] size=8+80
         [hdlr] size=12+48                            [hdlr] size=12+48
           handler_type = alis                          handler_type = alis
           handler_name = Apple Alias Data Handler       handler_name = Apple Alias Data Handler
         [dinf] size=8+28                             [dinf] size=8+28
           [dref] size=12+16                            [dref] size=12+16
             [alis] size=8+4                             [alis] size=8+4
         [stbl] size=8+164                            [stbl] size=8+164
           [stsd] size=12+60                            [stsd] size=12+60
             entry-count = 1                              entry-count = 1
             [tmcd] size=8+48                             [tmcd] size=8+48
               data_reference_index = 1                     data_reference_index = 1
           [stts] size=12+12                            [stts] size=12+12
             entry_count = 1                              entry_count = 1
           [stsc] size=12+16                            [stsc] size=12+16
             entry_count = 1                              entry_count = 1
           [stsz] size=12+8                             [stsz] size=12+8
             sample_size = 4                              sample_size = 4
             sample_count = 0                             sample_count = 0
           [stco] size=12+8                             [stco] size=12+8
             entry_count = 1                              entry_count = 1
     [udta] size=8+24                             [udta] size=8+24
       [kgtt] size=8+16                             [kgtt] size=8+16
 [meta] size=8+435982                         [meta] size=8+435982
   [hdlr] size=12+20                             [hdlr] size=12+20
     handler_type = mdta                           handler_type = mdta
```

```
   handler_name =                            handler_name =
[keys] size=8+2456                        [keys] size=8+2456
[ilst] size=8+433478                      [ilst] size=8+433478
  [....] size=8+52                           [....] size=8+52
  [....] size=8+20                           [....] size=8+20
  [....] size=8+17                           [....] size=8+17
  [....] size=8+31                           [....] size=8+31
  [....] size=8+21                           [....] size=8+21
  [....] size=8+21                           [....] size=8+21
  [....] size=8+20                           [....] size=8+20
  [....] size=8+18                           [....] size=8+18
  [....] size=8+16                           [....] size=8+16
  [....] size=8+20                           [....] size=8+20
  [....] size=8+20                           [....] size=8+20
  [....] size=8+16                           [....] size=8+16
  [....] size=8+16                           [....] size=8+16
  [....] size=8+16                           [....] size=8+16
  [....] size=8+16                           [....] size=8+16
  [....] size=8+16                           [....] size=8+16
  [....] size=8+16                           [....] size=8+16
  [....] size=8+20                           [....] size=8+20
  [....] size=8+24                           [....] size=8+24
  [....] size=8+20                           [....] size=8+20
  [....] size=8+20                           [....] size=8+20
  [....] size=8+16                           [....] size=8+16
  [....] size=8+23                           [....] size=8+23
  [....] size=8+48                           [....] size=8+48
  [....] size=8+24                           [....] size=8+24
  [....] size=8+24                           [....] size=8+24
  [....] size=8+20                           [....] size=8+20
  [....] size=8+20                           [....] size=8+20
  [....] size=8+40                           [....] size=8+40
  [....] size=8+20                           [....] size=8+20
  [....] size=8+20                           [....] size=8+20
  [... ] size=8+28                           [... ] size=8+28
  [...!] size=8+20                           [...!] size=8+20
  [..."] size=8+60                           [..."] size=8+60
  [...#] size=8+215704                       [...#] size=8+215704
  [...$] size=8+215704                       [...$] size=8+215704
  [...%] size=8+140                          [...%] size=8+140
```

```
        [...&] size=8+16                              [...&] size=8+16
        [...'] size=8+16                              [...'] size=8+16
        [...(] size=8+16                              [...(] size=8+16
        [...)] size=8+140                             [...)] size=8+140
        [...*] size=8+17                              [...*] size=8+17
        [...+] size=8+16                              [...+] size=8+16
        [...,] size=8+24                              [...,] size=8+24
        [...-] size=8+20                              [...-] size=8+20
        [....] size=8+20                              [....] size=8+20
        [.../] size=8+20                              [.../] size=8+20
        [...0] size=8+20                              [...0] size=8+20
        [...1] size=8+20                              [...1] size=8+20
        [...2] size=8+20                              [...2] size=8+20
        [...3] size=8+20                              [...3] size=8+20
        [...4] size=8+25                              [...4] size=8+25
        [...5] size=8+20                              [...5] size=8+20
        [...6] size=8+31                              [...6] size=8+31
        [...7] size=8+34                              [...7] size=8+34
        [...8] size=8+20                              [...8] size=8+20
        [...9] size=8+20                              [...9] size=8+20
        [...:] size=8+20                              [...:] size=8+20
        [...;] size=8+20                              [...;] size=8+20
        [...<] size=8+20                              [...<] size=8+20
        [...=] size=8+20                              [...=] size=8+20
        [...>] size=8+20                              [...>] size=8+20
     [free] size=8+2                              [free] size=8+2
     [udta] size=8+16                             [udta] size=8+16
       [apmd] size=8+4                              [apmd] size=8+4
   [wide] size=8+3300956                       [wide] size=8+3300944
```

264

265

266

267

268

269

270 Table 6. Structure and Format Analysis for "CHUCK_PERUTO_INTERVIEW_053018.mp4"

Evidence: CHUCK_PERUTO_INTERVIEW_053018.mp4	
Structure	Format
[ftyp] size=8+16	General
major_brand = mp42	Format : MPEG-4
minor_version = 0	Format profile : Base Media / Version 2
compatible_brand = mp42	Codec ID : mp42 (mp42/mp41)
compatible_brand = mp41	File size : 1.91 GiB
[moov] size=8+877051	Duration : 30 min 14 s
[mvhd] size=12+96	Overall bit rate mode : Variable
timescale = 90000	Overall bit rate : 9 039 kb/s
duration = 163332480	Encoded date : UTC 2018-10-31 01:56:04
duration(ms) = 1814805	Tagged date : UTC 2018-10-31 01:57:17
[trak] size=8+471737	TIM : 18:57:35:02
[tkhd] size=12+80, flags=1	TSC : 23976
enabled = 1	TSZ : 1000
id = 1	
duration = 163329416	Video
width = 852.000000	ID : 1
height = 480.000000	Format : AVC
[edts] size=8+28	Format/Info : Advanced Video Codec
[elst] size=12+16	Format profile : High@L4.2
entry count = 1	Format settings : CABAC / 4 Ref Frames
entry/segment duration = 163329416	Format settings, CABAC : Yes
entry/media time = 1001	Format settings, RefFrames: 4 frames
entry/media rate = 1	Codec ID : avc1
[mdia] size=8+471601	Codec ID/Info : Advanced Video Coding
[mdhd] size=12+20	Duration : 30 min 14 s
timescale = 24000	Bit rate mode : Variable
duration = 43554511	Bit rate : 8 718 kb/s
duration(ms) = 1814771	Maximum bit rate : 12.0 Mb/s
language = eng	Width : 852 pixels
[hdlr] size=12+52	Height : 480 pixels
handler_type = vide	Display aspect ratio : 16:9
handler_name = Mainconcept Video Media	Frame rate mode : Constant
Handler	Frame rate : 23.976 (24000/1001) FPS
[minf] size=8+471497	Standard : NTSC
[vmhd] size=12+8, flags=1	Color space : YUV
graphics_mode = 0	Chroma subsampling : 4:2:0

```
      op_color = 0000,0000,0000          Bit depth                  : 8 bits
  [hdlr] size=12+39                       Scan type                  : Progressive
   handler_type = alis                    Bits/(Pixel*Frame)         : 0.889
   handler_name = Alias Data Handler      Stream size                : 1.84 GiB (96%)
  [dinf] size=8+28                        Language                   : English
   [dref] size=12+16                      Encoded date               : UTC 2018-10-31 01:56:04
    [url ] size=12+0, flags=1             Tagged date                : UTC 2018-10-31 01:56:04
      location = [local to file]          Color range                : Limited
  [stbl] size=8+471382                    Color primaries            : BT.601 NTSC
   [stsd] size=12+163                     Transfer characteristics   : BT.601
    entry-count = 1                       Matrix coefficients        : BT.601
    [avc1] size=8+151                     Codec configuration box    : avcC
      data_reference_index = 1
      width = 852                         Audio
      height = 480                        ID                         : 2
      compressor = AVC Coding             Format                     : AAC LC
      [avcC] size=8+65                    Format/Info    : Advanced Audio Codec Low Complexity
        Configuration Version = 1         Codec ID                   : mp4a-40-2
        Profile = High                    Duration                   : 30 min 14 s
        Profile Compatibility = 0         Source duration            : 30 min 14 s
        Level = 42                        Bit rate mode              : Variable
        NALU Length Size = 4              Bit rate                   : 317 kb/s
        Sequence Parameter = [67 64 00 2a ac  Maximum bit rate       : 345 kb/s
2c a5 03 60 f7 9f ff c0 00 40 00 54 83 03 03 20 00  Channel(s)        : 2 channels
00 7d 20 00 17 70 1c 4c 00 02 dc 6c 00 01 c9 c3 7e  Channel layout    : L R
31 c1 da 16 2d 16]                        Sampling rate              : 48.0 kHz
        Picture Parameter = [68 e9 09 35 25]  Frame rate            : 46.875 FPS (1024 SPF)
   [stts] size=12+12                      Compression mode           : Lossy
    entry_count = 1                       Stream size                : 68.7 MiB (4%)
   [stss] size=12+7576                    Source stream size         : 68.7 MiB (4%)
    entry_count = 1893                    Language                   : English
   [sdtp] size=8+43515                    Encoded date               : UTC 2018-10-31 01:56:04
   [stsc] size=12+28                      Tagged date                : UTC 2018-10-31 01:56:04
    entry_count = 2
   [stsz] size=12+174052
    sample_size = 0
    sample_count = 43511
   [stco] size=12+17412
    entry_count = 4352
   [ctts] size=12+228532
```

```
              entry_count = 28566
  [trak] size=8+405126
    [tkhd] size=12+80, flags=1
      enabled = 1
      id = 2
      duration = 163329416
      width = 0.000000
      height = 0.000000
    [edts] size=8+28
      [elst] size=12+16
        entry count = 1
        entry/segment duration = 163329416
        entry/media time = 0
        entry/media rate = 1
    [mdia] size=8+404990
      [mdhd] size=12+20
        timescale = 48000
        duration = 87110656
        duration(ms) = 1814805
        language = eng
      [hdlr] size=12+56
        handler_type = soun
        handler_name = Mainconcept MP4 Sound Media
Handler
      [minf] size=8+404882
        [smhd] size=12+4
          balance = 0
        [hdlr] size=12+39
          handler_type = alis
          handler_name = Alias Data Handler
        [dinf] size=8+28
          [dref] size=12+16
            [url ] size=12+0, flags=1
              location = [local to file]
        [stbl] size=8+404771
          [stsd] size=12+79
            entry-count = 1
            [mp4a] size=8+67
              data_reference_index = 1
              channel_count = 2
```

```
                    sample_size = 16
                    sample_rate = 48000
                    [esds] size=12+27
                      [ESDescriptor] size=2+25
                        es_id = 0
                        stream_priority = 16
                        [DecoderConfig] size=2+17
                          stream_type = 5
                          object_type = 64
                          up_stream = 0
                          buffer_size = 1536
                          max_bitrate = 345373
                          avg_bitrate = 317375
                          DecoderSpecificInfo = 11 90
                        [Descriptor:06] size=2+1
              [stts] size=12+12
                entry_count = 1
              [stsc] size=12+46924
                entry_count = 3910
              [stsz] size=12+340284
                sample_size = 0
                sample_count = 85069
              [stco] size=12+17412
                entry_count = 4352
      [udta] size=8+56
        [.TIM] size=8+15
        [.TSC] size=8+9
        [.TSZ] size=8+8
[BE7ACFCB97A9-42E8-9C71-9994-91E3AFAC] size=24+5080
[free] size=8+5072
[mdat] size=16+2049595398
```

271

272

273

274

275

276   **7. Figures**
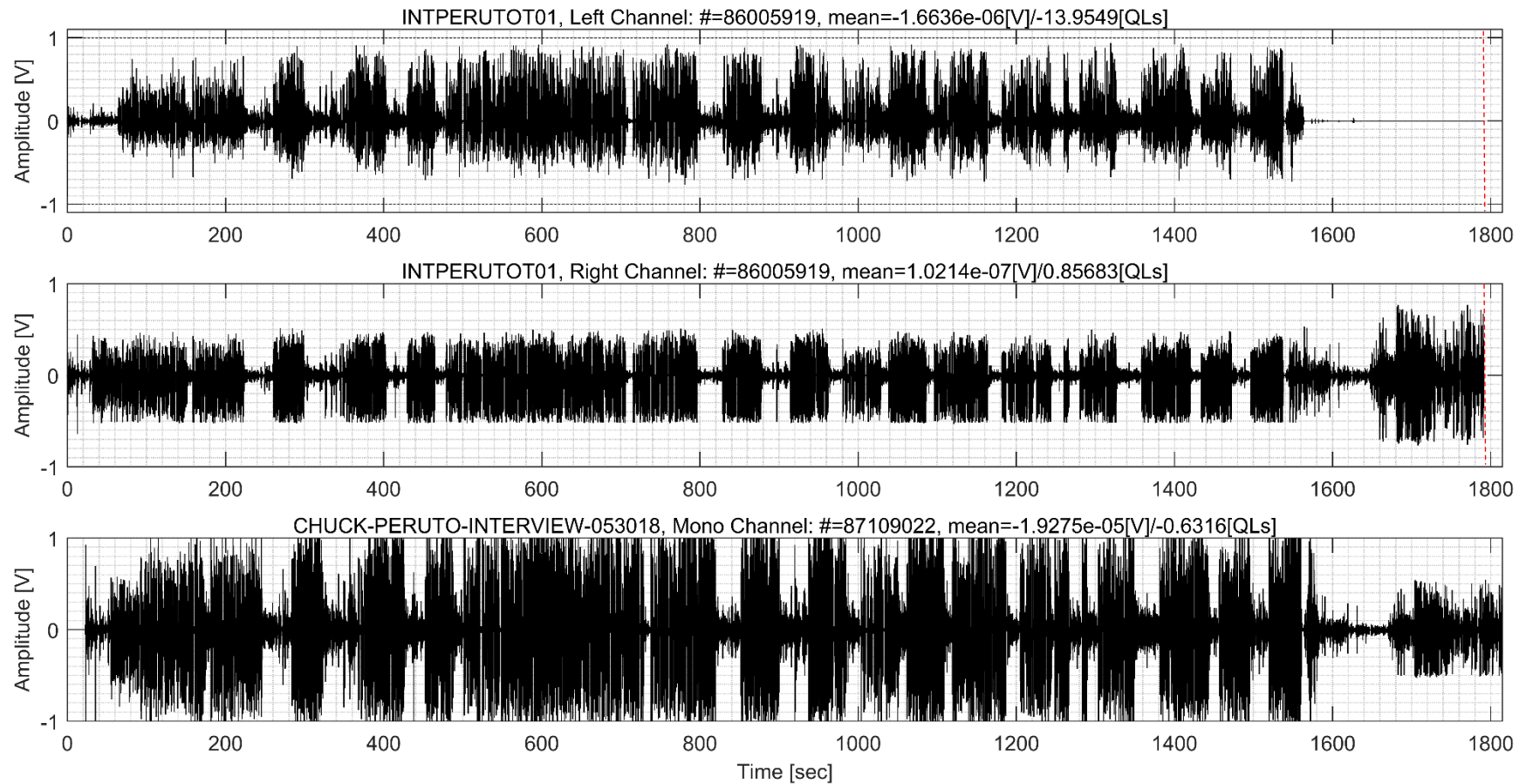
277

278   Figure 1. Waveform comparison between "INTPERUTOT01.WAV" and

279   "CHUCK_PERUTO_INTERVIEW_053018.mp4" audio signals

280

281

282
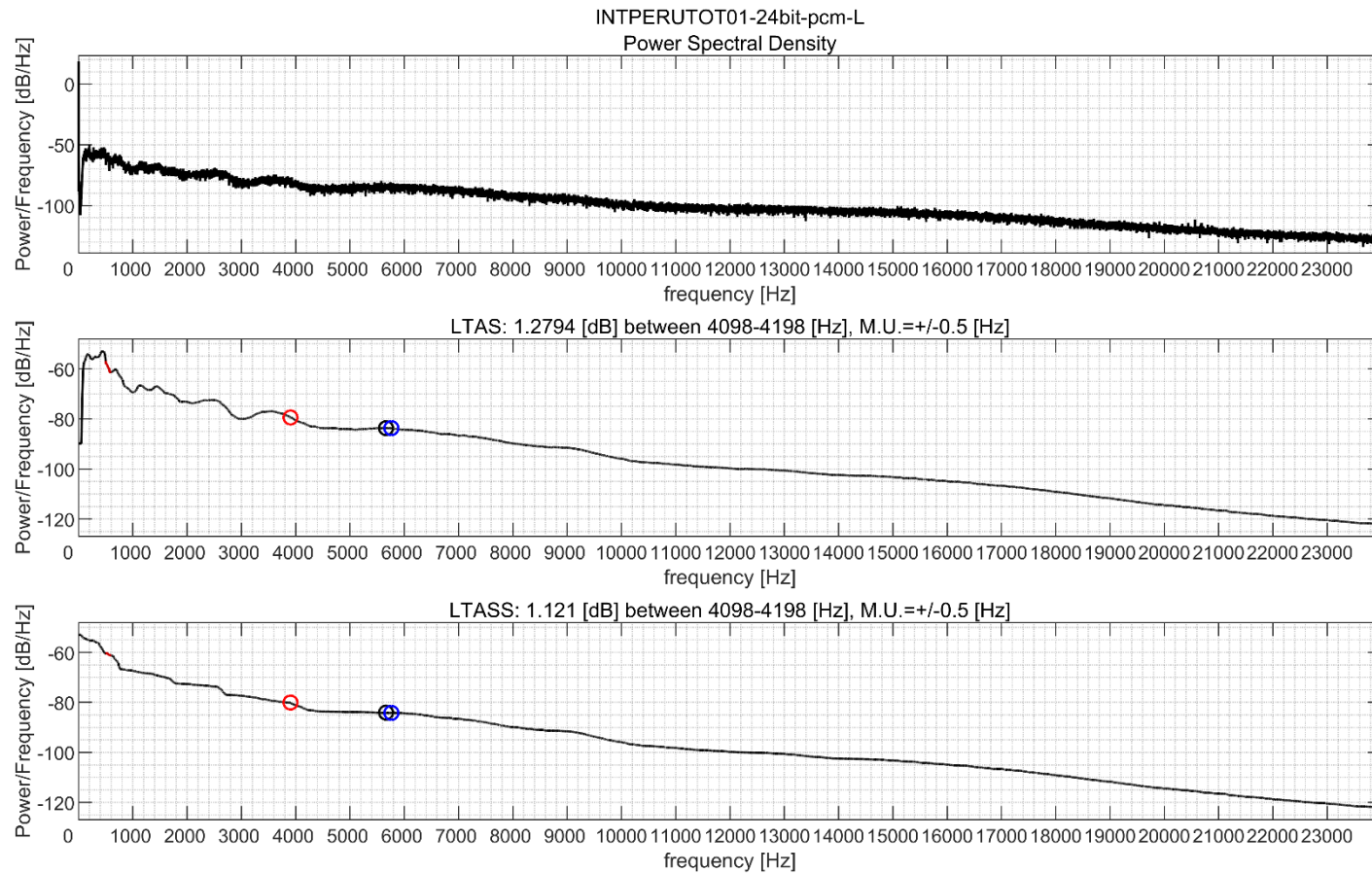
283   Figure 2. Power Spectral Density (PSD), Long Term Average Spectrum (LTAS), Long Term

284   Average Sorted Spectrum (LTASS) analyses for "INTPERUTOT01.WAV" left channel
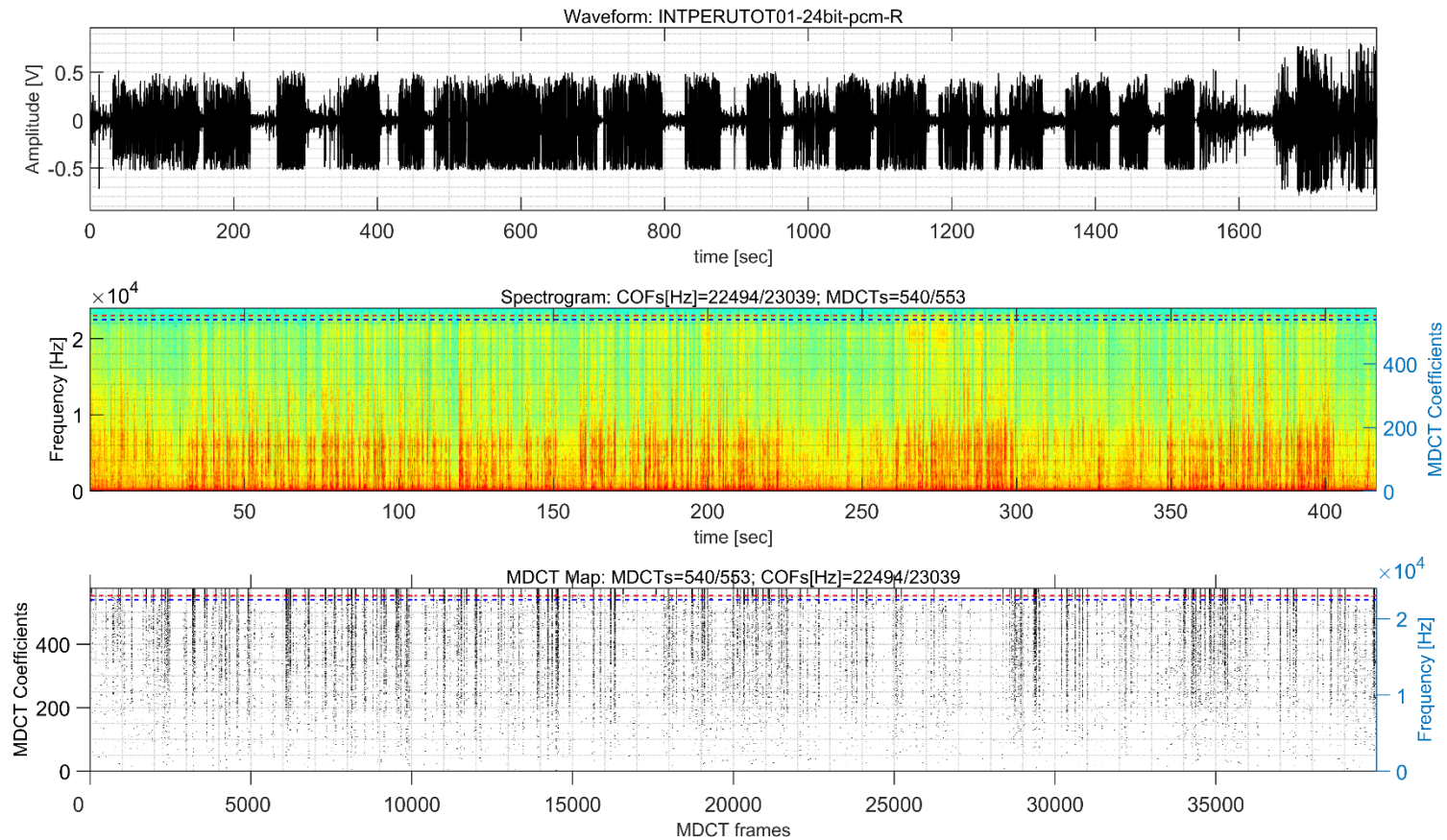
285

286
287
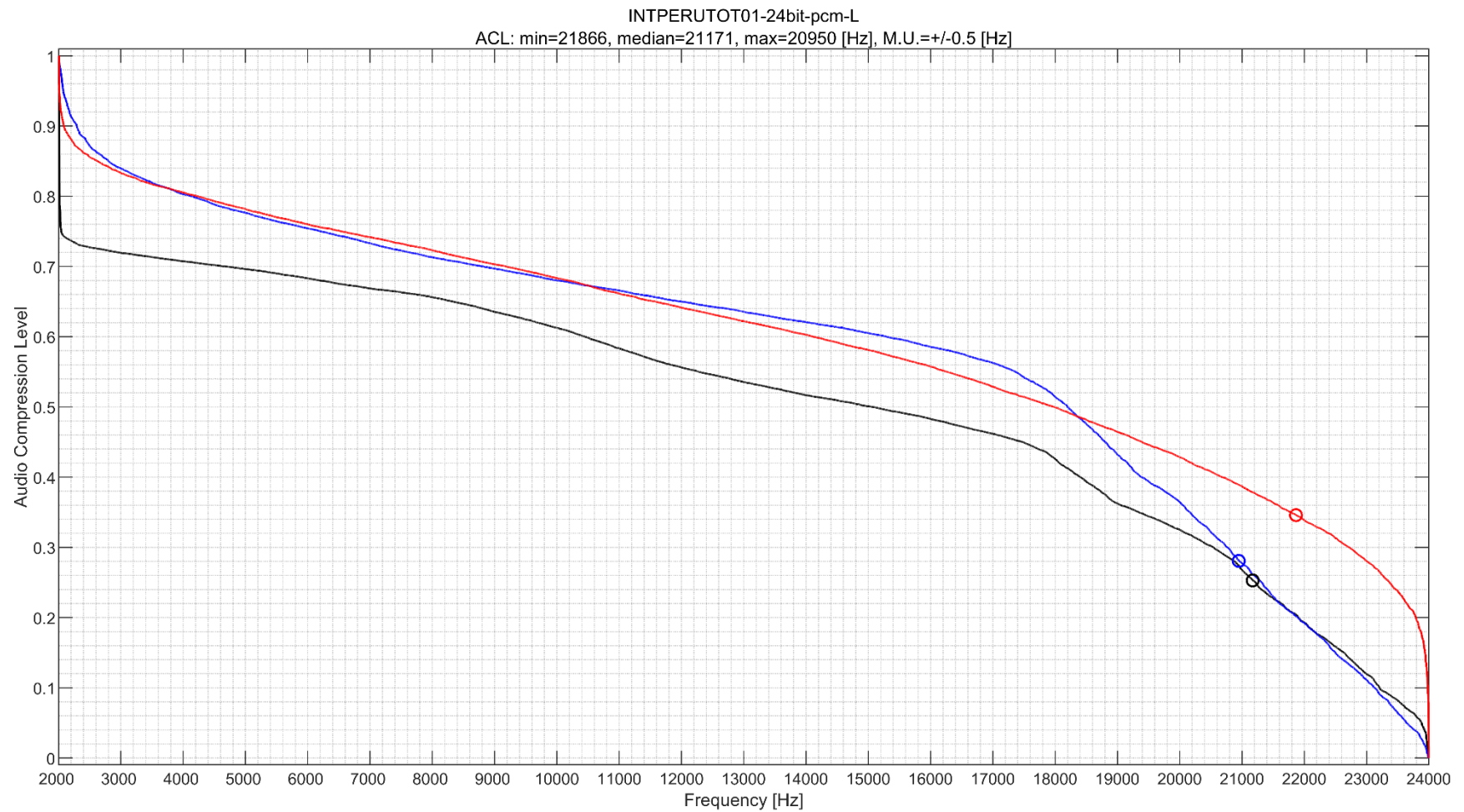
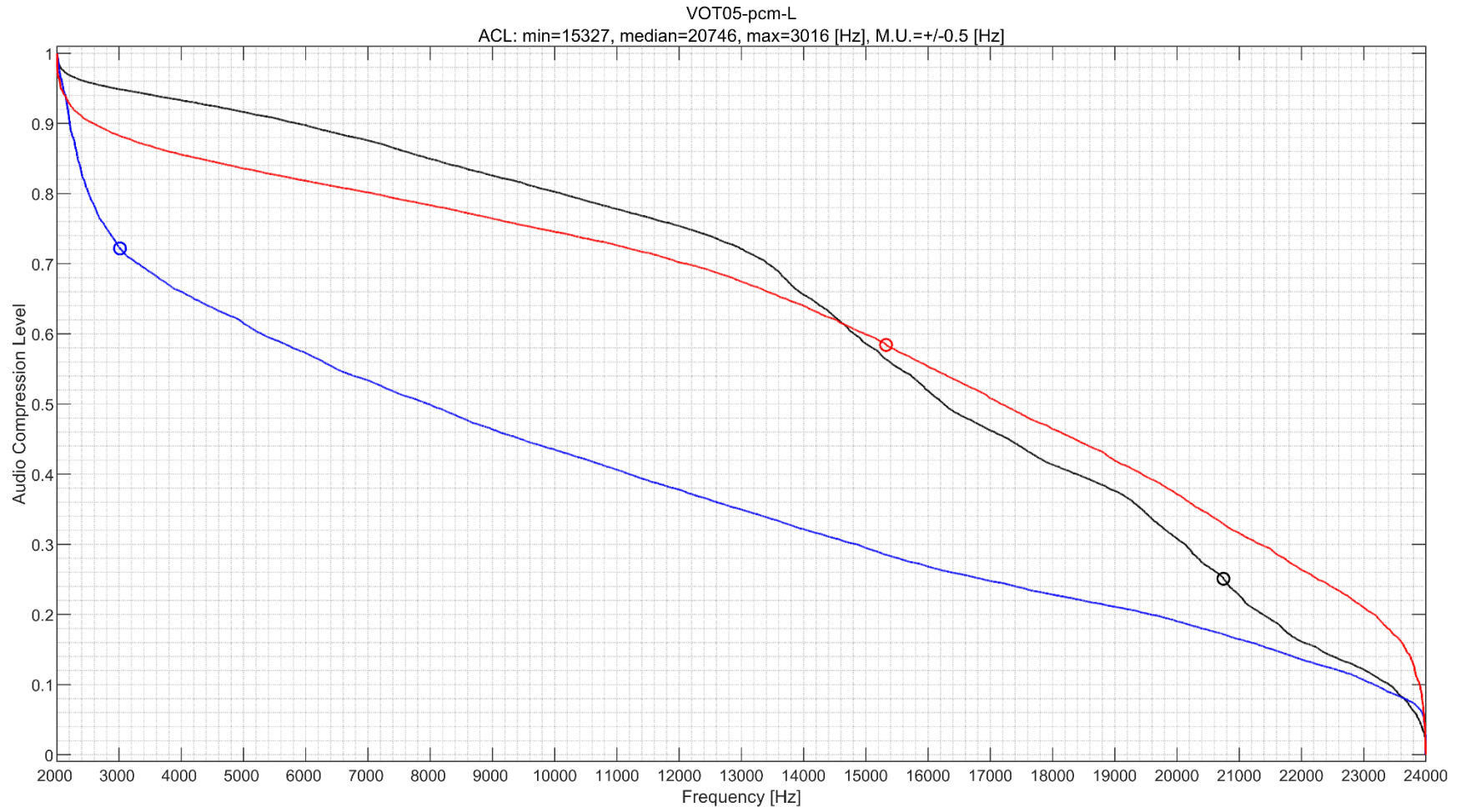288   Figure 3. Audio Compression Level (ACL) analysis for "INTPERUTOT01.WAV" left channel

289
290

291
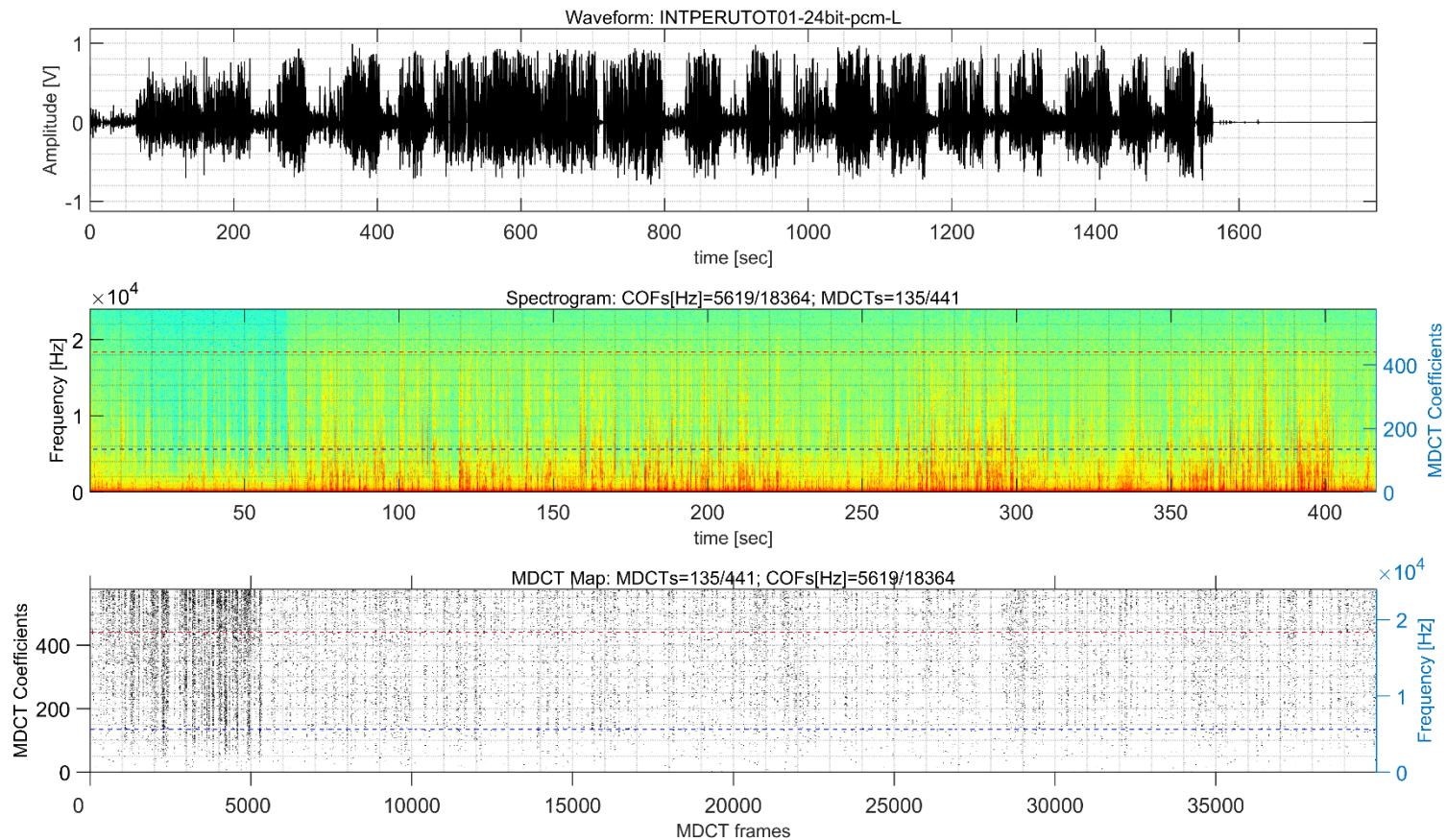
Figure 4. Waveform, Spectrogram, and Modified Discrete Cosine Transform (MDCT) analyses

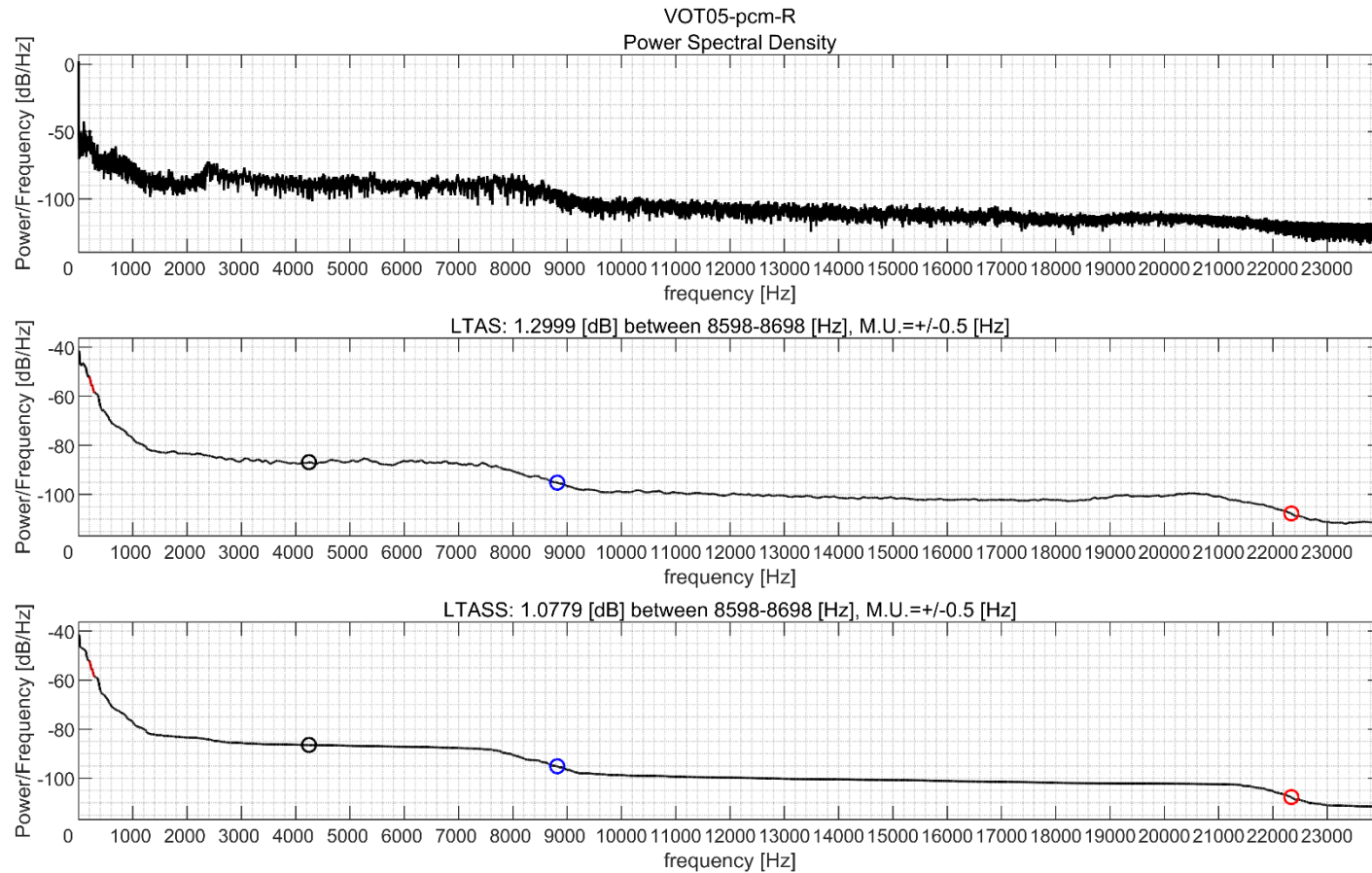for "INTPERUTOT01.WAV" left channel

294

295

296
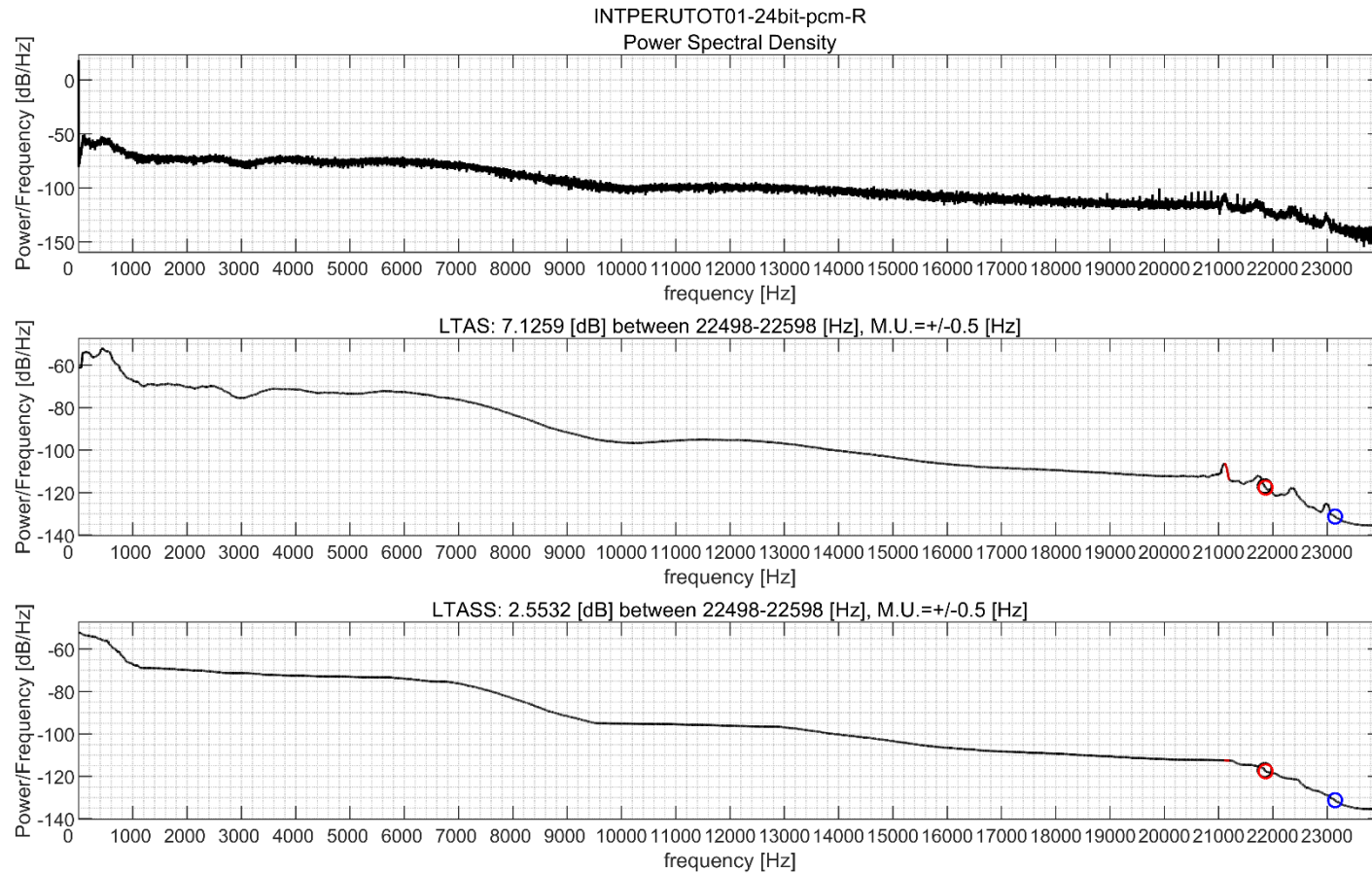
297

298   Figure 5. Power Spectral Density (PSD), Long Term Average Spectrum (LTAS), Long Term

299   Average Sorted Spectrum (LTASS) for "INTPERUTOT01.WAV" right channel

300

301
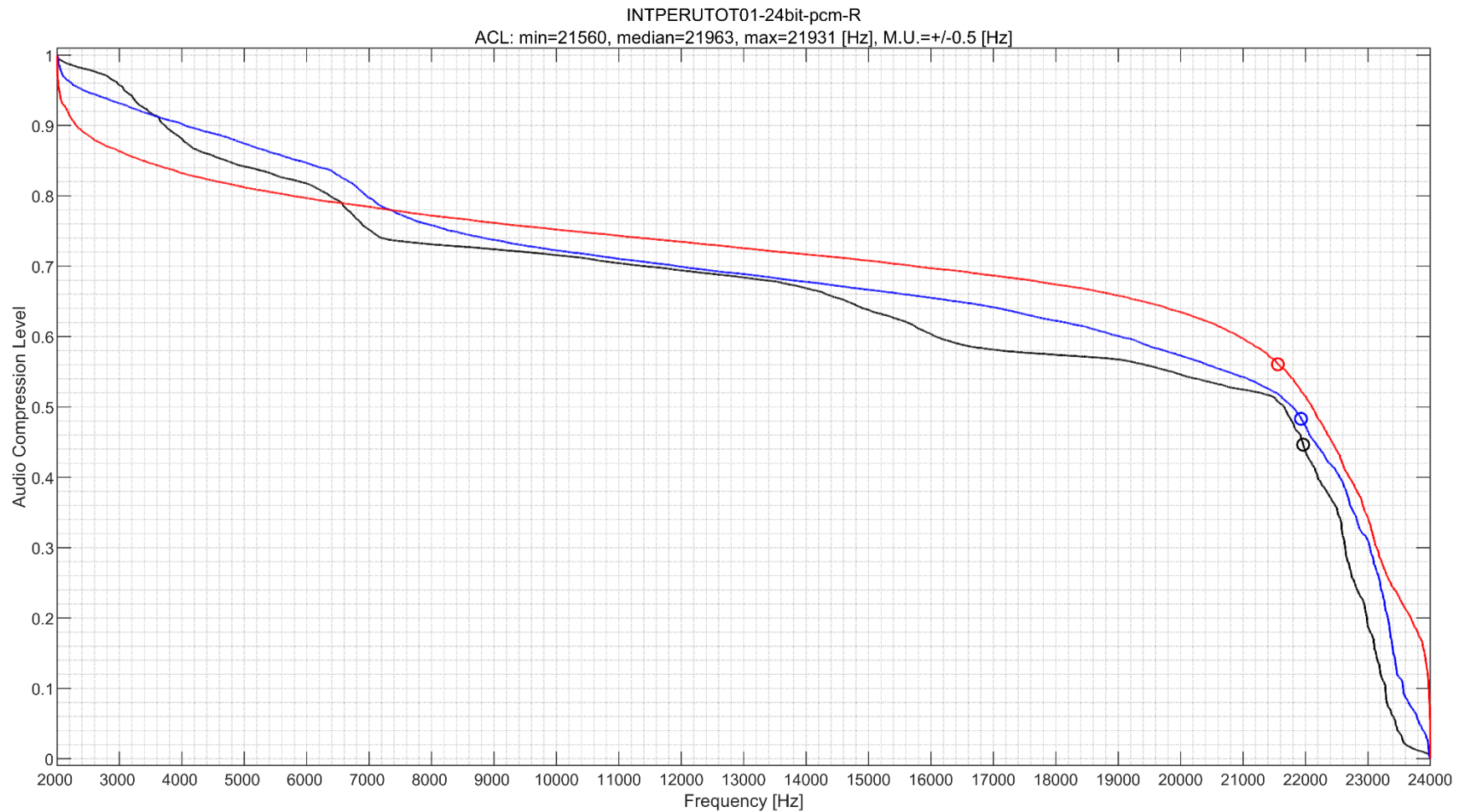
302
303
304   Figure 6. Audio Compression Level (ACL) analysis for "INTPERUTOT01.WAV" right channel
305

306

Figure 7. Waveform, Spectrogram, and Modified Discrete Cosine Transform (MDCT) analyses for "INTPERUTOT01.WAV" right channel

311
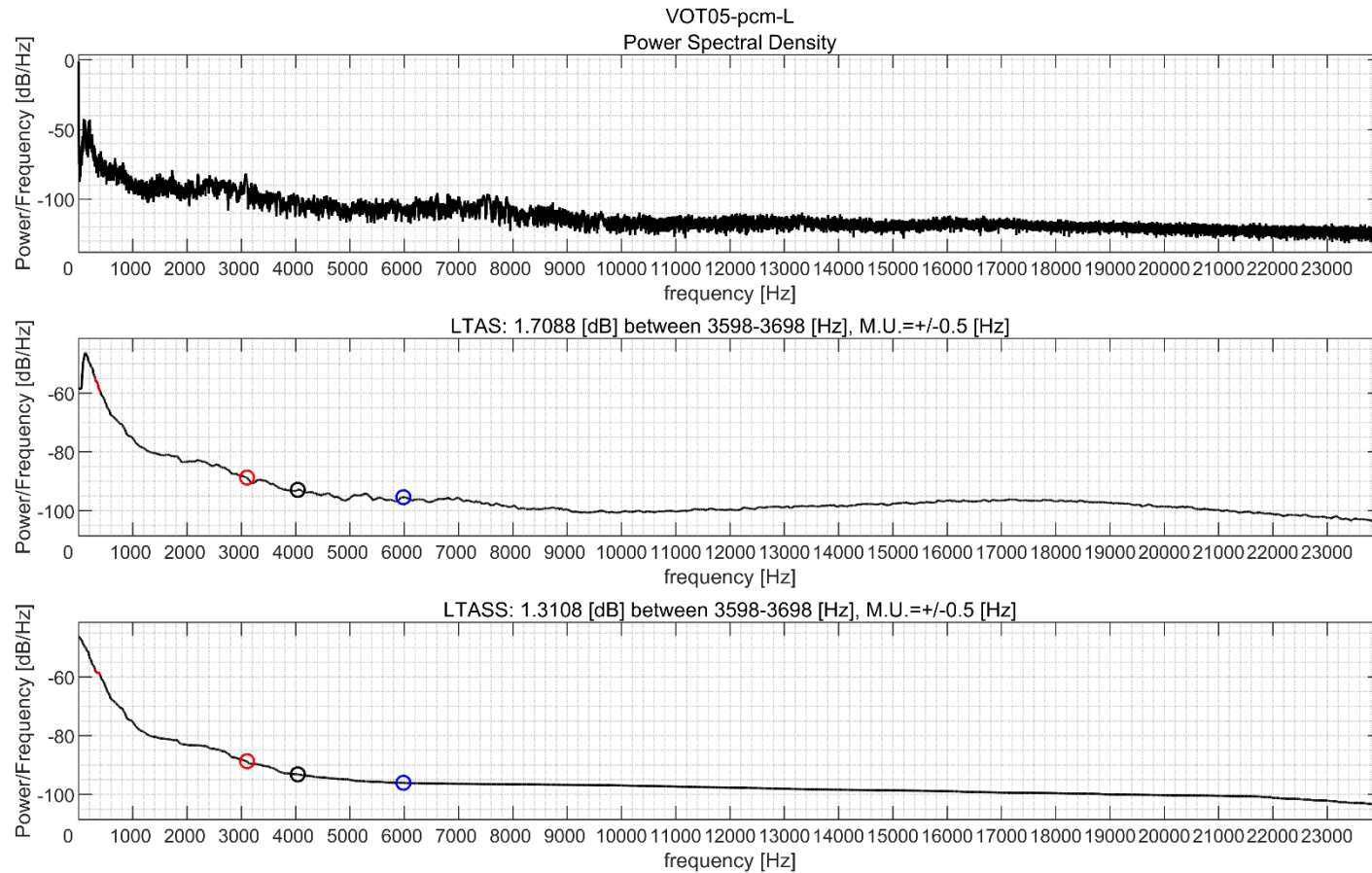
312

313   Figure 8. Power Spectral Density (PSD), Long Term Average Spectrum (LTAS), Long Term

314   Average Sorted Spectrum (LTASS) for reference recording "VOT05.WAV" left channel
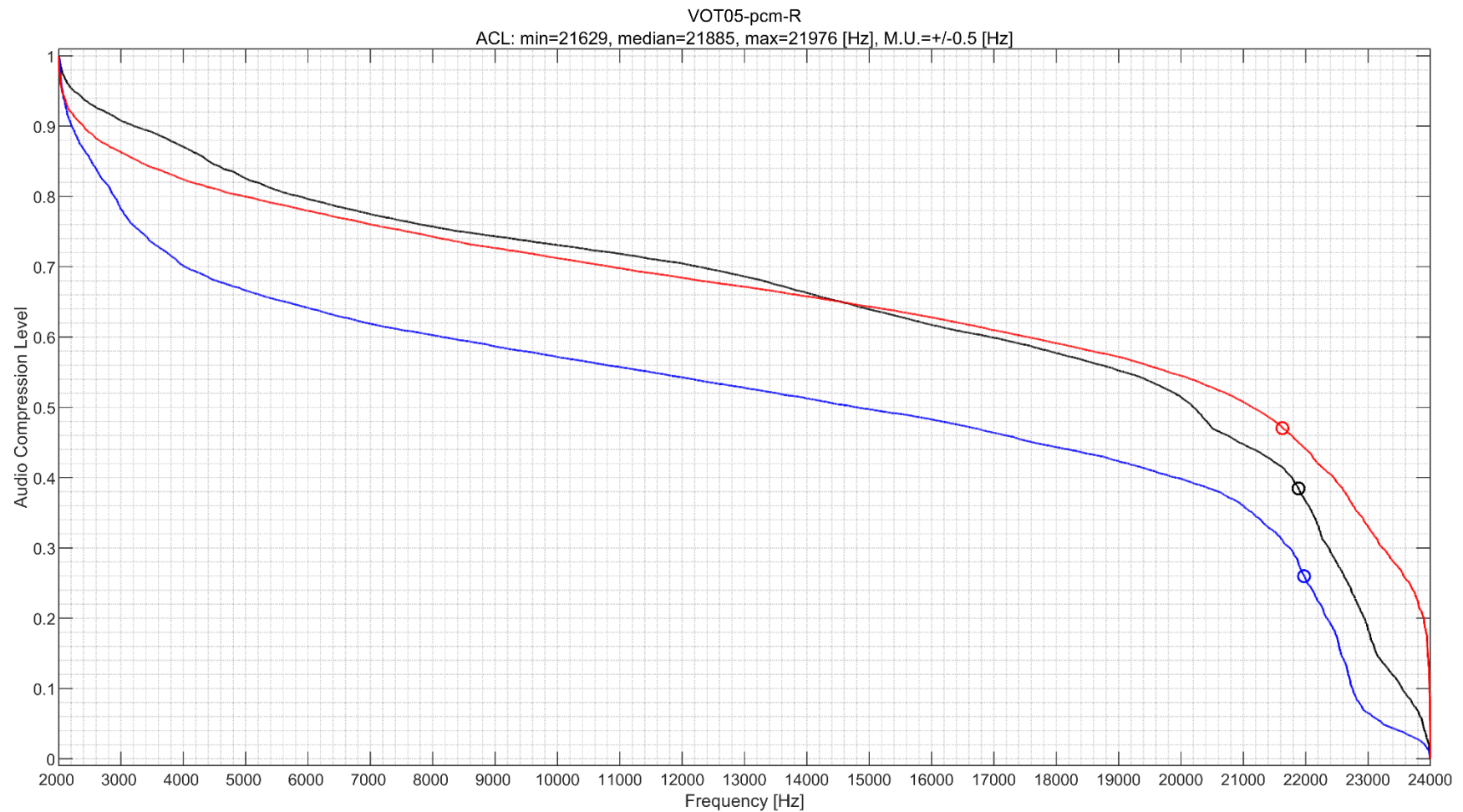
315

316

317

318   Figure 9. Audio Compression Level (ACL) analysis for reference recording "VOT05.WAV" left

319   channel
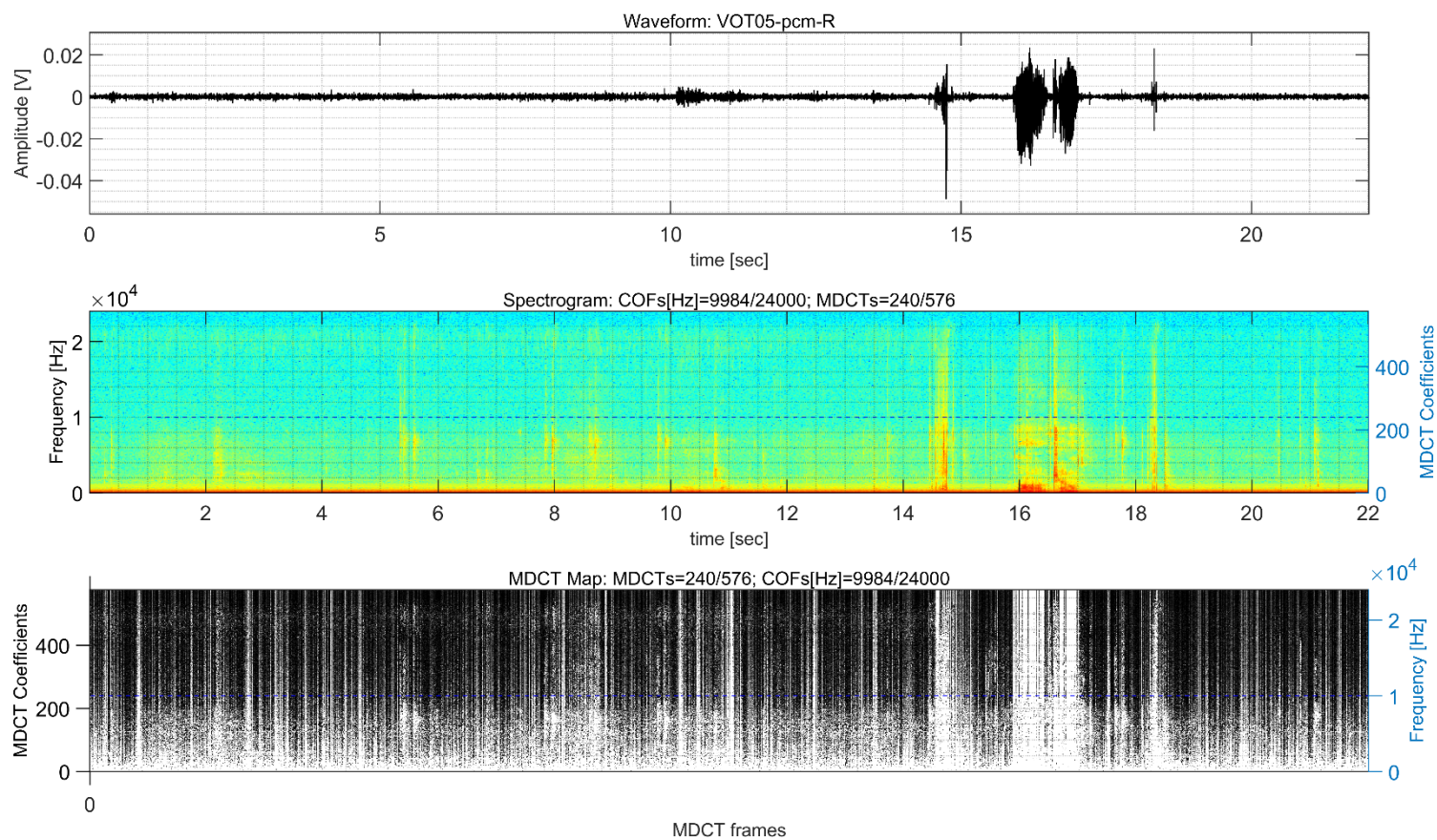
320

321

322

323
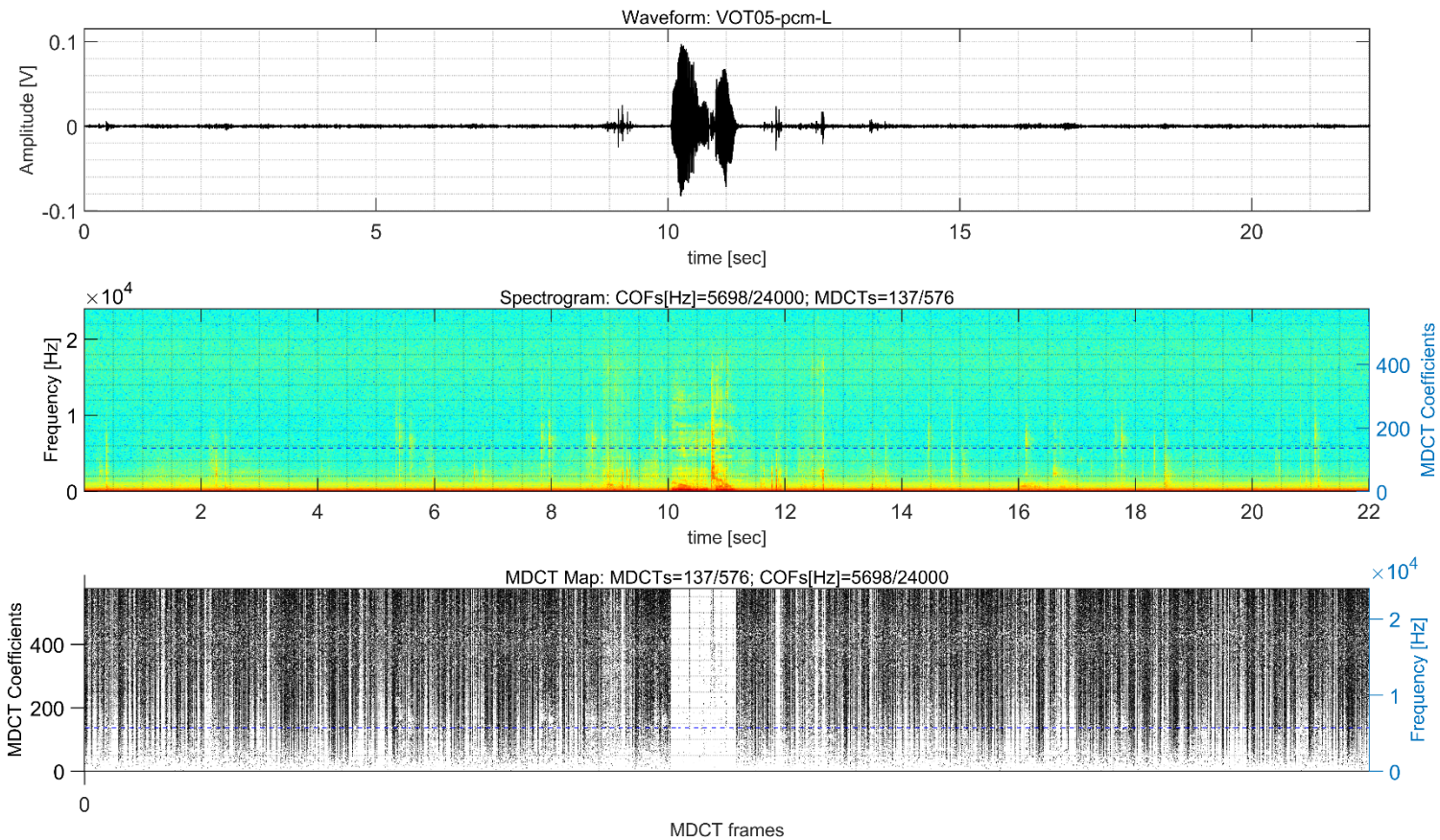
324   Figure 10. Waveform, Spectrogram, and Modified Discrete Cosine Transform (MDCT) analyses

325   for reference recording "VOT05.WAV" left channel

326

327

328

329   Figure 11. Power Spectral Density (PSD), Long Term Average Spectrum (LTAS), Long Term

330   Average Sorted Spectrum (LTASS) for reference recording "VOT05.WAV" right channel

331

332

Figure 12. Audio Compression Level (ACL) analysis for reference recording "VOT05.WAV"

right channel

336

337

338

339   Figure 13. Waveform, Spectrogram, and Modified Discrete Cosine Transform (MDCT) analyses

340   for reference recording "VOT05.WAV" right channel

8. References

[1] SWGDE Best Practices for Digital Audio Authentication, Version 1.3 (September 20, 2018).

[2] Grigoras C., Smith J.M. (2017) Large Scale Test of Digital Audio Structure and Format for Forensic Analysis, 2017 AES International Conference on Audio Forensics, Arlington VA, USA.

[3] Forensic Audio Analysis Review 2013-2016 by Catalin Grigoras, Jeff M. Smith, and Andrzej Drygajlo. Interpol 18th International Forensic Science Managers Symposium. 2016.

[4] Forensic Audio Analysis Review 2010-2013 by Catalin Grigoras, Jeff M. Smith, Geoffrey Stewart Morrison, and Ewald Enzinger. Interpol 17th International Forensic Science Managers Symposium. 2013.

[5] Grigoras C., and Smith J.M. (2013) Audio Enhancement and Authentication. In: Siegel JA and Saukko PJ (eds.) Encyclopedia of Forensic Sciences, Second Edition, pp. 315-326. Waltham: Academic Press.

[6] Grigoras, C., Rappaport, D., Smith, J. (2012) Analytical Framework for Digital Audio Authentication, AES 46th International Conference, Denver, USA.

[7] Statistical Tools for Multimedia Forensics by Catalin Grigoras. Audio Engineering Society 39th International Conference: Audio Forensics. 2010.